

constant within  $\pm 2.5\%$  of its respective mean or target flow rate. You may use the following options instead of recording the respective flow rate of each type of meter:

(1) *Critical-flow venturi option.* For critical-flow venturis, you may use recorded venturi-inlet conditions or their 1 Hz means. Demonstrate that the flow density at the venturi inlet was constant within  $\pm 2.5\%$  of the mean or target density over each test interval. For a CVS critical-flow venturi, you may demonstrate this by showing that the absolute temperature at the venturi inlet was constant within  $\pm 4\%$  of the mean or target absolute temperature over each test interval.

(2) *Positive-displacement pump option.* You may use recorded pump-inlet conditions or their 1 Hz means. Demonstrate that the flow density at the pump inlet was constant within  $\pm 2.5\%$  of the mean or target density over each test interval. For a CVS pump, you may demonstrate this by showing that the absolute temperature at the pump inlet was constant within  $\pm 2\%$  of the mean or target absolute temperature over each test interval.

(c) Using good engineering judgment, demonstrate with an engineering analysis that the proportional-flow control system inherently ensures proportional sampling under all circumstances expected during testing. For example, you might use CFVs for both sample flow and total dilute exhaust (CVS) flow and demonstrate that they always have the same inlet pressures and temperatures and that they always operate under critical-flow conditions.

[79 FR 23777, Apr. 28, 2014]

**§ 1065.546 Verification of minimum dilution ratio for PM batch sampling.**

Use continuous flows and/or tracer gas concentrations for transient and ramped-modal cycles to verify the minimum dilution ratios for PM batch sampling as specified in § 1065.140(e)(2) over the test interval. You may use mode-average values instead of continuous measurements for discrete mode steady-state duty cycles. Determine the minimum primary and minimum overall dilution ratios using one of the following methods (you may use a dif-

ferent method for each stage of dilution):

(a) Determine minimum dilution ratio based on molar flow data. This involves determination of at least two of the following three quantities: Raw exhaust flow (or previously diluted flow), dilution air flow, and dilute exhaust flow. You may determine the raw exhaust flow rate based on the measured intake air or fuel flow rate and the raw exhaust chemical balance terms as given in § 1065.655(e). You may determine the raw exhaust flow rate based on the measured intake air and dilute exhaust molar flow rates and the dilute exhaust chemical balance terms as given in § 1065.655(f). You may alternatively estimate the molar raw exhaust flow rate based on intake air, fuel rate measurements, and fuel properties, consistent with good engineering judgment.

(b) Determine minimum dilution ratio based on tracer gas (*e.g.*, CO<sub>2</sub>) concentrations in the raw (or previously diluted) and dilute exhaust corrected for any removed water.

(c) Use good engineering judgment to develop your own method of determining dilution ratios.

[75 FR 23043, Apr. 30, 2010, as amended at 76 FR 57451, Sept. 15, 2011; 79 FR 23778, Apr. 28, 2014]

**§ 1065.550 Gas analyzer range verification and drift verification.**

(a) *Range verification.* If an analyzer operated above 100% of its range at any time during the test, perform the following steps:

(1) For batch sampling, re-analyze the sample using the lowest analyzer range that results in a maximum instrument response below 100%. Report the result from the lowest range from which the analyzer operates below 100% of its range.

(2) For continuous sampling, repeat the entire test using the next higher analyzer range. If the analyzer again operates above 100% of its range, repeat the test using the next higher range. Continue to repeat the test until the analyzer always operates at less than 100% of its range.

(b) *Drift verification.* Gas analyzer drift verification is required for all gaseous exhaust constituents for which an

emission standard applies. It is also required for CO<sub>2</sub> even if there is no CO<sub>2</sub> emission standard. It is not required for other gaseous exhaust constituents for which only a reporting requirement applies (such as CH<sub>4</sub> and N<sub>2</sub>O).

(1) Verify drift using one of the following methods:

(i) For regulated exhaust constituents determined from the mass of a single component, perform drift verification based on the regulated constituent. For example, when NO<sub>x</sub> mass is determined with a dry sample measured with a CLD and the removed water is corrected based on measured CO<sub>2</sub>, CO, THC, and NO<sub>x</sub> concentrations, you must verify the calculated NO<sub>x</sub> value.

(ii) For regulated exhaust constituents determined from the masses of multiple subcomponents, perform the drift verification based on either the regulated constituent or all the mass subcomponents. For example, when NO<sub>x</sub> is measured with separate NO and NO<sub>2</sub> analyzers, you must verify either the NO<sub>x</sub> value or both the NO and NO<sub>2</sub> values.

(iii) For regulated exhaust constituents determined from the concentrations of multiple gaseous emission subcomponents prior to performing mass calculations, perform drift verification on the regulated constituent. You may not verify the concentration subcomponents (e.g., THC and CH<sub>4</sub> for NMHC) separately. For example, for NMHC measurements, perform drift verification on NMHC; do not verify THC and CH<sub>4</sub> separately.

(2) Drift verification requires two sets of emission calculations. For each set of calculations, include all the constituents in the drift verification. Calculate one set using the data before drift correction and calculate the other set after correcting all the data for drift according to §1065.672. Note that for purposes of drift verification, you must leave unaltered any negative emission results over a given test interval (i.e., do not set them to zero). These unaltered results are used when verifying either test interval results or composite brake-specific emissions over the entire duty cycle for drift. For each constituent to be verified, both

sets of calculations must include the following:

(i) Calculated mass (or mass rate) emission values over each test interval.

(ii) If you are verifying each test interval based on brake-specific values, calculate brake-specific emission values over each test interval.

(iii) If you are verifying over the entire duty cycle, calculate composite brake-specific emission values.

(3) The duty cycle is verified for drift if you satisfy the following criteria:

(i) For each regulated gaseous exhaust constituent, you must satisfy one of the following:

(A) For each test interval of the duty cycle, the difference between the uncorrected and the corrected brake-specific emission values of the regulated constituent must be within ±4% of the uncorrected value or the applicable emissions standard, whichever is greater. Alternatively, the difference between the uncorrected and the corrected emission mass (or mass rate) values of the regulated constituent must be within ±4% of the uncorrected value or the composite work (or power) multiplied by the applicable emissions standard, whichever is greater. For purposes of verifying each test interval, you may use either the reference or actual composite work (or power).

(B) For each test interval of the duty cycle and for each mass subcomponent of the regulated constituent, the difference between the uncorrected and the corrected brake-specific emission values must be within ±4% of the uncorrected value. Alternatively, the difference between the uncorrected and the corrected emissions mass (or mass rate) values must be within ±4% of the uncorrected value.

(C) For the entire duty cycle, the difference between the uncorrected and the corrected composite brake-specific emission values of the regulated constituent must be within ±4% of the uncorrected value or applicable emission standard, whichever is greater.

(D) For the entire duty cycle and for each subcomponent of the regulated constituent, the difference between the uncorrected and the corrected composite brake-specific emission values must be within ±4% of the uncorrected value.

(ii) Where no emission standard applies for CO<sub>2</sub>, you must satisfy one of the following:

(A) For each test interval of the duty cycle, the difference between the uncorrected and the corrected brake-specific CO<sub>2</sub> values must be within ±4% of the uncorrected value; or the difference between the uncorrected and the corrected CO<sub>2</sub> mass (or mass rate) values must be within ±4% of the uncorrected value.

(B) For the entire duty cycle, the difference between the uncorrected and the corrected composite brake-specific CO<sub>2</sub> values must be within ±4% of the uncorrected value.

(4) If the test is not verified for drift as described in paragraph (b)(1) of this section, you may consider the test results for the duty cycle to be valid only if, using good engineering judgment, the observed drift does not affect your ability to demonstrate compliance with the applicable emission standards. For example, if the drift-corrected value is less than the standard by at least two times the absolute difference between the uncorrected and corrected values, you may consider the data to be verified for demonstrating compliance with the applicable standard.

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**§ 1065.590 PM sampling media (e.g., filters) preconditioning and tare weighing.**

Before an emission test, take the following steps to prepare PM sampling media (e.g., filters) and equipment for PM measurements:

(a) Make sure the balance and PM-stabilization environments meet the periodic verifications in § 1065.390.

(b) Visually inspect unused sample media (e.g., filters) for defects and discard defective media.

(c) To handle PM sampling media (e.g., filters), use electrically grounded tweezers or a grounding strap, as described in § 1065.190.

(d) Place unused sample media (e.g., filters) in one or more containers that are open to the PM-stabilization environment. If you are using filters, you may place them in the bottom half of a filter cassette.

(e) Stabilize sample media (e.g., filters) in the PM-stabilization environ-

ment. Consider an unused sample medium stabilized as long as it has been in the PM-stabilization environment for a minimum of 30 min, during which the PM-stabilization environment has been within the specifications of § 1065.190.

(f) Weigh the sample media (e.g., filters) automatically or manually, as follows:

(1) For automatic weighing, follow the automation system manufacturer's instructions to prepare samples for weighing. This may include placing the samples in a special container.

(2) For manual weighing, use good engineering judgment to determine if substitution weighing is necessary to show that an engine meets the applicable standard. You may follow the substitution weighing procedure in paragraph (j) of this section, or you may develop your own procedure.

(g) Correct the measured mass of each sample medium (e.g., filter) for buoyancy as described in § 1065.690. These buoyancy-corrected values are subsequently subtracted from the post-test mass of the corresponding sample media (e.g., filters) and collected PM to determine the mass of PM emitted during the test.

(h) You may repeat measurements to determine the mean mass of each sample medium (e.g., filter). Use good engineering judgment to exclude outliers from the calculation of mean mass values.

(i) If you use filters as sample media, load unused filters that have been tare-weighed into clean filter cassettes and place the loaded cassettes in a clean, covered or sealed container before removing them from the stabilization environment for transport to the test site for sampling. We recommend that you keep filter cassettes clean by periodically washing or wiping them with a compatible solvent applied using a lint-free cloth. Depending upon your cassette material, ethanol (C<sub>2</sub>H<sub>5</sub>OH) might be an acceptable solvent. Your cleaning frequency will depend on your engine's level of PM and HC emissions.

(j) Substitution weighing involves measurement of a reference weight before and after each weighing of PM sampling media (e.g., filters). While substitution weighing requires more